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ABSTRACT

This paper reports on two experiments conducted in an attempt to extend findings by Ellis which suggest a rehearsal deficit in mentally retarded subjects. In experiment one, mentally retarded subjects saw nine stimuli in a serial position probe task for either two, four, or six seconds each. Performances for the two and four second-per-item rates of presentation did not differ and were similar to those obtained by Ellis for rates of presentation of two seconds or less. However, when stimuli were shown for six seconds each, performance was facilitated. In experiment two, seven stimuli were presented at rates of four, six, or eight seconds per item. During this interval stimuli were exposed for either two seconds or for the entire interval. The eight-second presentation rate was superior for both exposure durations to the four- and six-second rates, which did not differ from each other. (Author/WR)

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PRIMACY EFFECTS IN SHORT-TERM MEMORY WITH THE MENTALLY RETARDED

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Ellis (1970) has presented evidence demonstrating a short-term memory deficit in mentally retarded individuals, which is postulated to result from a limitation in rehearsal abilities. The conception of memory upon which Ellis bases these conclusions is similar to that of Waugh and Norman (1965). The model consists of three independent processes: Primary, Secondary, and Tertiary Memory. The first two processes define short-term memory, while the last is equivalent to long-term memory. Subjectively, Primary Memory (PM) is defined as those events still in mind and Secondary Memory (SM) as those events from the near past which are out of mind but still capable of being remembered. In the standard short-term memory paradigm these independent processes are operationally represented by different parts of the resulting serial position curve. Memory for the last few items in a list, the recency portion of the curve, represents PM. SM is defined by memory for the remaining list items. The function of rehearsal is to transfer items from unstable PM of limited capacity to the more stable and larger SM. To be retained, an item must be rehearsed.

Rehearsal processes are extremely important in this scheme of memory. PM is a transient store and its content is limited to only a few items. New items encoded by the subject displace older items previously stored there. A displaced item is forgotten. Only if an item is rehearsed and transferred

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to SM can it be retained for any appreciable period. Limitation of a subject's rehearsal abilities would drastically reduce efficient use of the larger SM and he would have to rely heavily on PM. The disadvantage would be most apparent in circumstances where a lot of information had to be rapidly processed and retained for future use. These are situations in which the mentally retarded often fail. Besides describing the academic situation, deficiencies in rapid processing and retention for future use also characterize other indicators of mental retardation. For instance, retardates are notably poor performers on tests of digit span. Aware of these indicators, Ellis has sought experimental verification of the deficiency which produces them.

One piece of evidence which Ellis presents makes a particularly convincing argument for a rehearsal deficit in the mentally retarded. When subjects of normal intelligence are shown lists at different rates of presentation, increased length of presentation leads to increasing improvement in recall of early items. Memory for recent items, though, is unchanged. Better recall of initial items is attributed to the greater time allowed for rehearsal at the slower rates. With more rehearsal, more items are transferred from PM to SM. Increased transfer into larger SM leads to superior retention of these items, which is reflected by better recall in the primacy portion of the list. This does not occur with mentally deficient subjects. Ellis found that for presentation rates of up to 2 sec. per item, memory as reflected by the serial position curve was unchanged. The lack of improvement of the retarded subjects at slower rates of presentation seems best explained in terms of a rehearsal deficit. The present experi-

ments sought to extend these findings to longer rates of presentation for retarded subjects. In the process, some unexpected results were obtained.

Experiment I

Method

Subjects. Three groups of 10 subjects each were randomly composed of adults employed at a county-sponsored workshop. The mean IQ's for the groups receiving 2, 4, and 6 sec. per item rates of presentation were 58.8, 58.2, and 59.7, with standard deviations of 11.1, 11.5, and 12.9 respectively.

Apparatus and procedure. The positional probe task used here is like the one described by Atkinson, Hansen, and Bernbach (1964); Calfee, Heatherington, and Waltzer (1966); and Ellis (1970). The task is fashioned after a card guessing game. In this case, the cards consisted of two identical sets of nine pictures similar to those found at lower levels of the Peabody Picture Vocabulary Test (e.g., ball, wagon, tree). One set served as stimuli in the original list, while one card from the second set was used as a probe on each trial. The pictures were drawn in color on 3-in. squares of heavy poster board.

At the start of the experimental session the subject was seated across a table from the experimenter and was given instructions. After the experimenter was sure that the subject understood the task, the first of 36 trials began. At the start of each trial the stimulus cards were shuffled. The experimenter then said, "Ready," and held the first stimulus card in front of the subject. When it had been presented for the required time it was laid face down to the subject's left and the next card was presented. After

the appropriate interval this card was placed face down next to the first. When all nine cards had been presented in a similar manner and were lying in a row in front of the subject, the experimenter presented a tenth card. The tenth card, or probe, was from the second set of cards and was identical to one of those in the original series. The subject's task was to remember where the probe's mate had occurred in the original set. He indicated his response by turning over the card he thought to be like the probe. If he was wrong he continued responding until he found the match. All of the subject's responses were recorded by a second experimenter. After the subject had responded correctly, the stimulus cards were again shuffled and the next trial began. During the experiment, memory for each of the nine serial positions was tested four times, making a total of 36 trials for each subject.

A subject saw each stimulus item for either 2, 4, or 6 sec., depending upon the condition to which he was assigned. The experimenter regulated rate of stimulus presentation by presenting cards in synchrony with the "click" of a recycling electromechanical timer set for the proper interval. At the longer rates of presentation and less frequently at the shorter ones, a subject would sometimes look away from the card being presented. When this occurred, the experimenter would remind the subject to keep watching the card. If boredom became a problem, the session was terminated and the task was completed at a later date. Though subjects receiving the 6-sec. rate of presentation required more sessions to complete the experiment, individual sessions were about the same length or longer than sessions for the other two groups. Each session lasted from a half to two hours, depending on the subject's tolerance.

Results

The data for analysis consisted of first choice correct responses made to each serial position. Each subject could make up to four correct responses to each serial position. Figure 1 shows the results in terms of percentage of total possible first choice correct responses. Viewing the

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Insert Fig. 1 about here

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stimuli for 4 sec. each did not produce any better performance than viewing them for 2 sec. each. In fact, the serial position curves for the 2 and 4 sec. per item rates of presentation are nearly identical except for variations at a few positions, which are probably due either to an over-representation of easy or difficult items at these positions or to slight response biases. However, when items are presented for 6 sec. each, a marked improvement in recall for items in the primacy portion of the serial position curve results. This facilitation is evident for the first seven serial positions.

These results are supported by a two-way analysis of variance conducted on the within-subject factor of serial position and the between-subject factor of rate of presentation. Superiority of the group viewing each stimulus for 6 sec. is confirmed by the rate of presentation main effect, F (2, 27) = 5.1, $p < .05$. However, the Serial Position X Rate of Presentation interaction did not reach statistical significance because at the 6-sec. rate of presentation, performance at eight of nine serial positions was superior to the average performance at the 2- and 4-sec. rates. The effect is evidently large.

Experiment II

This experiment was conducted to determine if the results of Exp. I could be attributed to attentional factors. If longer presentation rates serve simply to draw a subject's attention to the stimulus being presented, then variations in interitem interval with exposure duration held constant should not produce the effect observed in Exp. I. On the other hand, exposure of the stimulus item for the entire duration of the presentation interval should produce the same effect.

Method

Subjects. The 36 subjects of this experiment were from the same source as those of Exp. I, in which some had participated. Mean IQ's for the three groups were 52.92, 52.83, and 58.66, with standard deviations of 7.84, 10.93, and 16.27 respectively. The difference in mean IQ between the extreme groups was not significant, t (22) = 1.10, $p < .20$.

Design. The design was a 3 X 2 X 2 X 7 complete factorial. Presentation Interval (4, 6, or 8 sec. per item) and Experimenter (two experimenters ran equal numbers of subjects) were varied between subjects. Exposure Duration (2 sec. per item or the entire presentation interval) and Serial Position (1-7) were varied within subjects.

Procedure. The procedure and materials were similar to those used in Exp. I. Two of the items used as stimulus materials in Exp. I were eliminated so that the stimulus set now consisted of seven items. Each subject in this experiment received 35 trials for each exposure duration, during which each serial position was probed five times. Half of the subjects received 35 trials using the 2-sec. exposure duration, followed by 35 trials

in which the stimulus item was exposed for the entire presentation interval. This order was reversed for the remaining subjects. Under all conditions an electromechanical timer "clicked" every 2 sec. and the experimenter presented the stimuli in synchrony with these clicks. When the stimulus items were presented for the entire interval, the experimenter held each facing the subject for the entire period. When they were presented for only 2 sec. of the presentation interval, each was held before the subject for 2 sec. and then placed face down in its appropriate position for the remainder of the interval (2, 4, and 6 sec. for the 4, 6, and 8 sec. presentation intervals respectively).

Results

The data for analysis consisted of first choice correct responses made to each serial position. Averaged results, collapsed across serial positions, are shown in Figure 2. Analysis of variance confirmed the obvious.

Insert Fig. 2 about here

The main effect of Presentation Interval, F (2, 30) = 3.70, $p < .05$, indicated that stimulus items were better remembered when presented at a rate of 8 sec. per item than when presented at a rate of 4 or 6 sec. per item. There were no significant effects of Exposure Duration, nor did Serial Position interact with Presentation Interval. There was a large main effect of Experimenter, F (1, 30) = 49.51, $p < .001$, but this factor did not interact significantly with any of the treatment conditions. The results of this

experiment appear to duplicate those of the last, except that the shorter list of this experiment required a slower presentation rate to demonstrate the facilitative effect. It seems reasonable to conclude that attentional factors did not play a part in the observed effect.

Discussion

The rehearsal deficit postulated by Ellis is confirmed by results obtained here for fast and intermediate presentation rates in both experiments. In fact, our results at fast and intermediate rates of presentation are very similar to the results he obtained for rates of presentation of 2 sec. per item and less (Ellis, 1970, p. 12). However, the improvement in performance observed when stimulus items are presented at slower presentation rates appears to indicate that some mechanism for transfer of items from PM to SM does exist in mentally retarded subjects.

An observation related to differences between the two experiments may be useful in interpreting the obtained results. In Exp. I, improved performance was obtained when a nine-item list was presented at a rate of 6 sec. per item, but in Exp. II this effect was replicated only when the seven-item list was presented at a rate of 8 sec. per item. It may be that for a given task there is an optimal presentation rate for retarded subjects. This may not be true for normal subjects. An examination of the literature revealed few experiments which provide critical tests of this position. However, several findings do support this hypothesis, though they have not been explained in this way. Gordon (1968) has found larger deficits for mentally retarded subjects than for normal subjects on a short-term memory task at faster rates of presentation. At least two paired-associate experi-

ments have also found trends toward optimal rates of presentation for retarded subjects which are different from those for normals. Ring (1965) used 2- or 4-sec. anticipation intervals with other intervals held constant. A reanalysis of her data shows that total learning time decreased at longer anticipation intervals for retarded subjects but increased slightly for normal subjects. Baumeister, Hawkins, and Davis (1965) varied stimulus-response pair presentation rates from 1 to 8 sec. while holding other intervals constant and found a decrease in errors for 5-, 6-, and 7-sec. presentation rates but not for an 8-sec. rate or for those rates less than 5 sec. No such trend was found for normal subjects matched for MA or CA.

Optimal rates of presentation might be indicative of different learning strategies among retarded subjects than are found with normal subjects. It might also indicate that retarded subjects are less flexible in their use of learning strategies, perhaps because they have fewer strategies available. Some support for the notion that retarded subjects might use different strategies comes from a study by Siipola and Hayden (1965) in which they found a higher incidence of imagery among mentally retarded than among normal subjects.

The major point of this research, however, is that the memory deficit postulated by Ellis for retarded individuals does not appear to hold for longer presentation rates. Ellis' model may only be representative of processes naturally occurring in individuals of normal intelligence. Detterman and Ellis (1970) factor analyzed data from eight experiments in which the probe task was used. Each of the five experiments conducted with normal subjects produced the same factor pattern. First and middle serial positions

loaded on the factor which accounted for the greatest portion of the variance. Middle and last serial positions loaded on a second factor. These factors were taken to represent SM and PM respectively. In two of the three experiments using normal and retarded children this pattern did not emerge, and results were difficult to interpret. They were originally thought to be due principally to unreliable data. It may have been that subjects were attempting to use a strategy which was unsuitable for the presentation rates employed in these investigations. Indeed, in the one experiment in which the factor pattern obtained for adults was replicated with retarded children, some of the subjects were told how to rehearse.

In future studies with retarded subjects in which rate of presentation is manipulated, it would seem advisable to use much wider ranges than have traditionally been employed.

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Footnote

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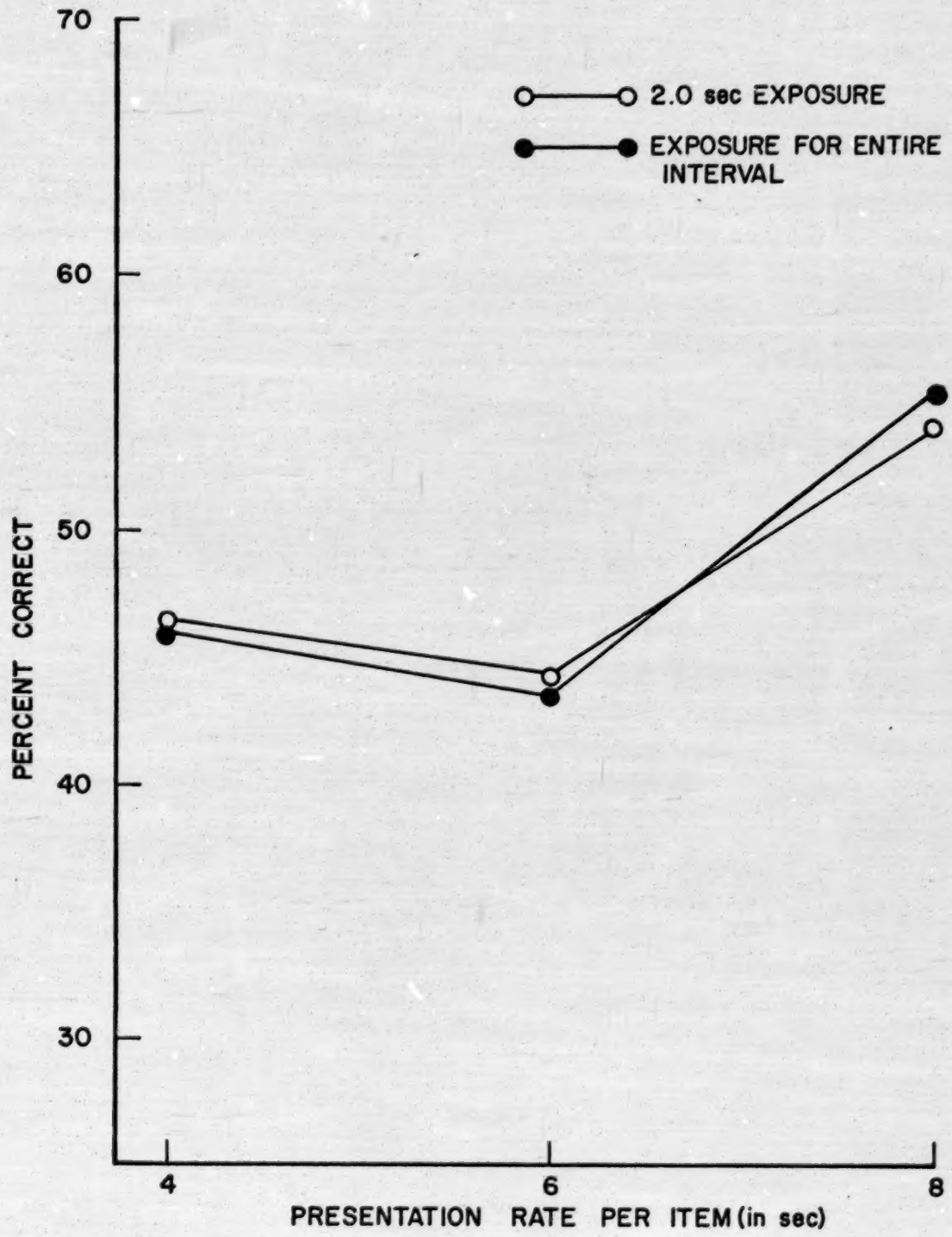
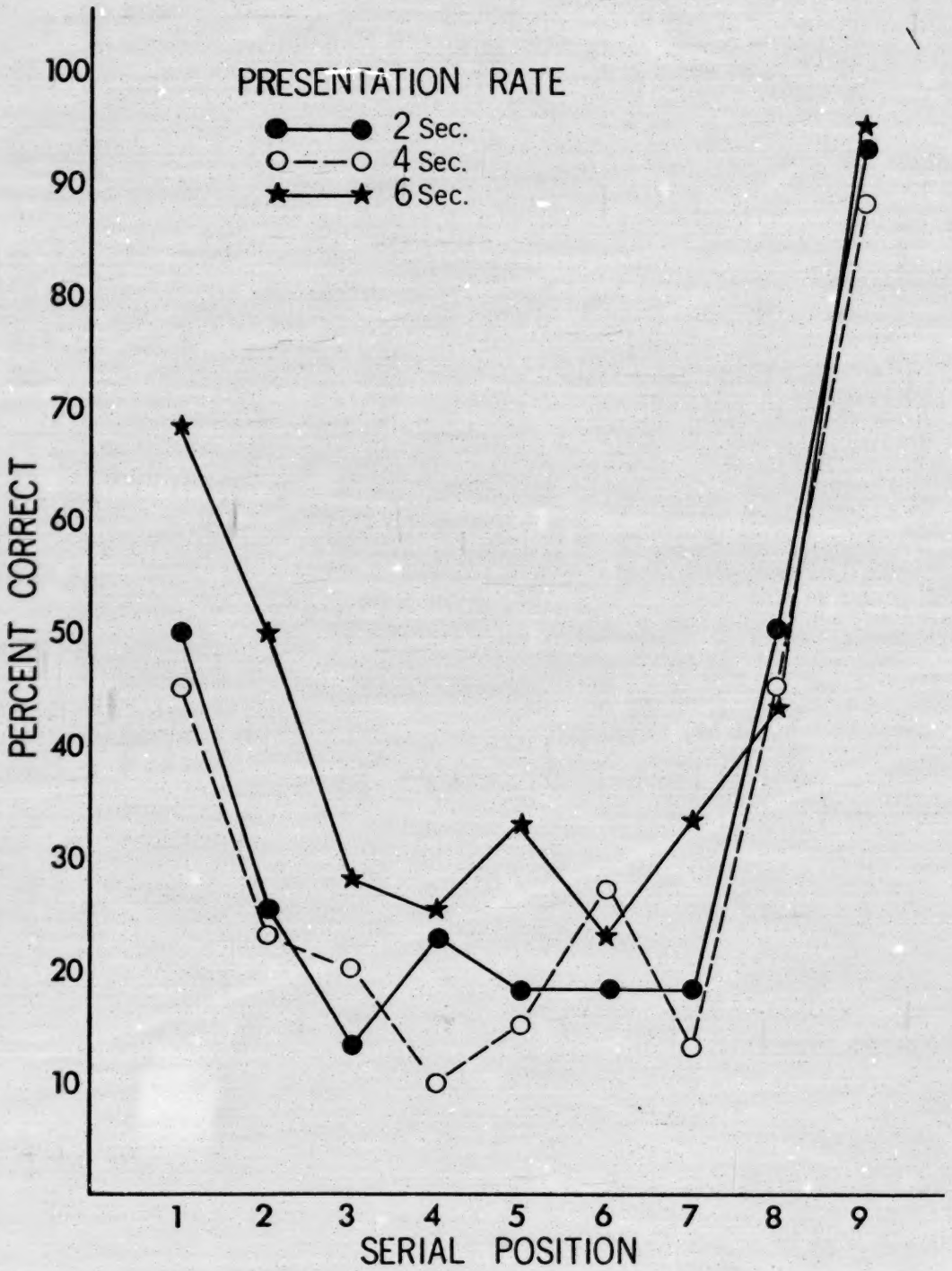
Figure Captions

Fig. 1. Percentage first choice correct responses by serial position for the three rates of presentation of Exp. I.

Fig. 2. Percentage first choice correct responses by presentation interval and exposure duration.


70
60
50
40
30
PERCENT CORRECT
2.0 sec EXPOSURE
EXPOSURE FOR ENTIRE INTERVAL
4
6
8
PRESENTATION RATE PER ITEM (in sec)


PRESENTATION RATE
2 Sec.
4 Sec.
6 Sec.
PERCENT CORRECT
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
SERIAL POSITION